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Research on the Current Situation and Countermeasures of Coal Mine Safety Management in China under the New Circumstances

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Abstract

By analyzing the current safety situation, management status, and existing problems in China's coal mines, innovative safety management strategies are proposed based on the application of new technologies, optimization of management systems, improvement of personnel quality, and cultural development. The research shows that coal mine safety management needs to keep pace with the times, make full use of advanced technologies, improve management systems, enhance personnel quality, and strengthen safety culture development. This provides theoretical guidance and practical references for coal mining enterprises to enhance safety management levels under the new circumstances.

Keywords

Coal Mine Safety; Safety Management; Current Safety Situation; Management Countermeasures.

1. Introduction

With the rapid development of China's economy and the continuous growth of energy demand, coal mine safety production issues have increasingly attracted attention from all sectors of society [1-2]. In recent years, the overall safety situation in China's coal mines has shown a steady and positive trend, with the number of accidents and fatalities continuing to decline [3-7]. However, coal mine safety production still faces numerous challenges: on one hand, as shallow resources are gradually depleted, mining depths are increasing, geological conditions are becoming more complex, and risks from gas, water hazards, and rock bursts are intensifying [8-9]. On the other hand, some coal mining enterprises lack sufficient safety investments, use outdated safety technology and equipment, and have uneven workforce quality, leaving room for improvement in safety management levels [10-12]. These exposed issues continue to lead to frequent safety accidents. For example, on January 12, 2024, a major coal and gas outburst accident occurred at the 12th Mine of Pingdingshan Tianan Coal Industry, resulting in 16 fatalities. On December 20, 2023, a safety accident at the Kunyuan Coal Mine in Jixi City, Heilongjiang Province, caused 12 fatalities. On November 16, 2023, a fire at the Yongju Coal Mine in Lüliang City, Shanxi Province, resulted in 26 fatalities.

Under the new circumstances, coal mining enterprises are facing stricter safety regulatory requirements, more complex geological conditions, and higher societal expectations, making traditional safety management models increasingly inadequate to meet current needs [13-14]. Based on the above analysis, this paper aims to explore innovative strategies for coal mine safety management in the new context to address the increasingly severe safety challenges. By analyzing the current coal mine safety situation and safety management status, innovative safety management strategies are proposed, focusing on the application of new technologies,

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optimization of management systems, improvement of personnel quality, and cultural development. These strategies provide a reference for coal mining enterprises to enhance their safety management levels

2. Analysis of the Current Situation and Challenges in Coal Mine Safety Management

At present, China's coal mine safety management system has been initially established, including the responsibility system for safety production, safety management regulations, and safety training systems. Most coal mining enterprises have established specialized safety management agencies, equipped with full-time safety management personnel, and formulated corresponding safety management systems and operating procedures. However, in practice, coal mine safety management still faces numerous problems. Firstly, some coal mining enterprises have a weak safety awareness, prioritizing production over safety, resulting in insufficient safety investments and outdated safety facilities and equipment. Secondly, the implementation of safety management systems is inadequate, with a tendency towards formalism, where safety inspections become superficial, and hazard rectifications are incomplete. Thirdly, the quality of employees varies, with some workers having weak safety awareness and frequent violations of operating procedures. Lastly, the effectiveness of safety education and training is poor, with training content often disconnected from actual work, leading to slow improvement in employees' safety skills.

Under the new circumstances, coal mine safety management faces multifaceted challenges. Firstly, in terms of technical challenges, as mining depths increase, geological conditions become more complex, making traditional safety technologies inadequate. The prevention and control of disasters such as gas outbursts, water hazards, and rock bursts have become more difficult, requiring the development and application of more advanced safety technologies. At the same time, the application of intelligent and automated technologies also poses new demands for safety management. Secondly, in terms of management challenges, traditional safety management models struggle to meet the requirements of the new situation. The safety management system needs further refinement, safety management regulations need to be more detailed, and safety inspections and hazard rectifications need to be stricter and more effective. Additionally, balancing the relationship between safety and efficiency, and improving production efficiency while ensuring safety, are significant management challenges for coal mining enterprises. Thirdly, in terms of personnel challenges, the overall quality of coal mine employees needs improvement. Some workers have weak safety awareness and insufficient safety skills, leading to frequent violations of operating procedures. Moreover, with the application of new technologies and equipment, the skill requirements for employees are continuously increasing, posing new challenges for safety training and education. Finally, in terms of environmental challenges, coal mining enterprises face stricter safety regulations and higher societal expectations. National laws and regulations are continuously being improved, and safety supervision is being intensified. At the same time, public attention to coal mine safety is increasing, placing greater social pressure on coal mining enterprises.

3. Innovative Strategies for Coal Mine Safety Management and Implementation Safeguard

Facing the challenges of the new era, coal mining enterprises need to innovate safety management strategies to enhance safety management levels. Firstly, they should fully utilize new technologies such as the Internet of Things, big data, and artificial intelligence to build intelligent safety monitoring systems, enabling real-time monitoring, early warning, and

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emergency response. For example, sensor networks can be used to monitor key parameters such as gas concentration, temperature, and humidity in real time. Through big data analysis, potential risks can be predicted, and preventive measures can be taken promptly. Secondly, the safety management system should be optimized by improving the responsibility system for safety production, refining safety management regulations, and strengthening safety inspections and hazard rectifications. Advanced safety management methods, such as risk pre-control management systems and intrinsic safety management systems, can be introduced to enhance the scientific and effective nature of safety management. At the same time, a sound safety performance evaluation mechanism should be established, linking safety performance to individual and departmental rewards and penalties to strengthen overall safety awareness. Thirdly, efforts should be made to improve personnel quality by enhancing the safety training system and innovating training methods. Virtual Reality (VR) Technology can be used for safety training to increase immersion and effectiveness. Additionally, emphasis should be placed on cultivating employees' safety awareness and skills, encouraging their participation in safety management to create a culture of whole-team involvement in safety management. Lastly, safety culture development should be strengthened by fostering a "people-oriented, safety-first" philosophy. Activities such as safety knowledge competitions and safety culture months can be organized to create a positive safety culture atmosphere. Furthermore, a safety behavior incentive mechanism should be established to encourage employees to proactively report safety hazards and actively participate in safety improvements, fostering good safety behavior habits.

To ensure the effective implementation of innovative coal mine safety management strategies, support must be provided in four areas: organizational safeguard, institutional safeguard, technical safeguard, and financial safeguard. Firstly, in terms of organizational safeguards coal mining enterprises should establish and improve safety management organizational structures, clarify the safety responsibilities of managers at all levels, and form a comprehensive safety management network that covers all aspects horizontally and vertically. At the same time, the safety management team should be strengthened to enhance the professional competence and capabilities of safety management personnel. Secondly, in terms of institutional safeguard, the safety management system should be improved by formulating practical safety operating procedures and emergency plans. A sound safety inspection and hazard identification and rectification system should be established to ensure timely identification and rectification of safety hazards. Additionally, a safety performance evaluation and reward and penalty system should be improved, linking safety performance to individual and departmental rewards and penalties to enhance overall safety awareness. In terms of technical safeguards, investment in safety technology should be increased, and advanced safety technologies and equipment should be promoted and applied. For example, intelligent safety monitoring systems, automated mining equipment, and intelligent gas drainage systems can be introduced to improve the intrinsic safety level of mines. At the same time, safety technology research and development should be strengthened, encouraging collaboration between enterprises and research institutions to develop safety technologies and equipment tailored to the specific conditions of the mine. Finally, in terms of financial safeguard, coal mining enterprises should ensure safety investments by incorporating safety costs into the enterprise budget to guarantee the updating and maintenance of safety facilities and equipment. Additionally, long-term mechanisms for safety investment should be explored, such as establishing special safety funds for safety technology research and development, safety facility upgrades, and safety education and training.

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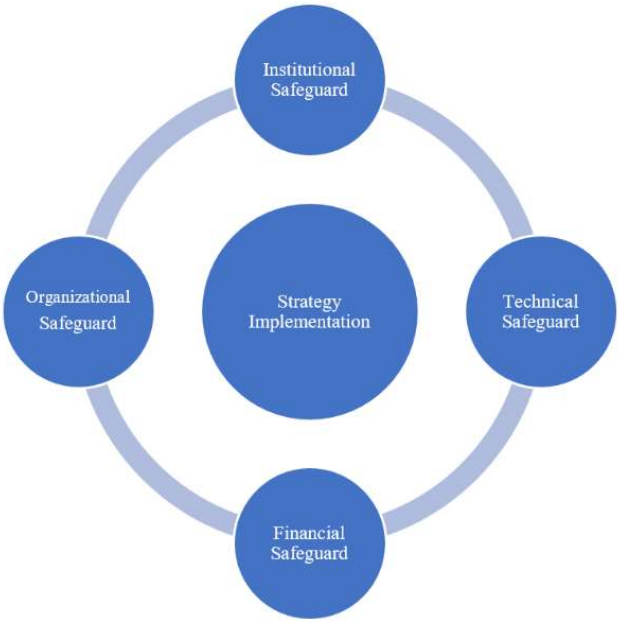

Figure 1. Safeguards for the effective implementation of innovative strategies in coal mine safety management

4. Case Study on Safety Management Innovation Practices in a Coal Mining Enterprise

To better illustrate the practical application effects of innovative coal mine safety management strategies, this paper selects a large coal mining enterprise (hereinafter referred to as "Coal Mine A") as a case for analysis. In recent years, Coal Mine A has significantly improved its safety management level by implementing a series of innovative safety management measures, providing valuable insights for other coal mining enterprises.

(1) Innovations in Technology Application

The mine introduced an IoT-based intelligent safety monitoring system, enabling real-time monitoring and early warning of key parameters such as gas concentration, temperature, and humidity. At the same time, by utilizing big data analysis technology, a safety risk prediction model was established, allowing for the early identification of potential risks and the implementation of preventive measures. Additionally, Coal Mine A applied virtual reality (VR) technology for safety training, enhancing the effectiveness of training and employee engagement.

(2) Optimization of the Management System

Coal Mine A introduced a risk pre-control management system and established a comprehensive safety risk assessment mechanism. The mine refined its safety management regulations, strengthened safety inspections and hazard rectifications, and established a closed-loop management process. Furthermore, Coal Mine A improved its safety performance evaluation mechanism, linking safety performance to individual and departmental rewards and penalties, effectively enhancing overall safety awareness.

(3) Improvement of Personnel Quality

Coal Mine A established a comprehensive safety training system, adopting various training methods such as on-site practical training, VR simulation training, and online learning, improving the relevance and effectiveness of training. The mine also implemented a "mentorship" system, where experienced employees guide new employees, promoting the passing down and improvement of safety skills.

(4) Development of Safety Culture

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Coal Mine A carried out diverse safety culture activities, such as safety knowledge competitions and safety culture months, creating a positive safety culture atmosphere. The mine also established a safety behavior incentive mechanism, encouraging employees to proactively report safety hazards and actively participate in safety improvements, fostering good safety behavior habits.

By implementing these innovative strategies, Coal Mine A has significantly improved its safety management level, substantially reduced its accident rate, and noticeably enhanced employee safety awareness, laying a solid foundation for the enterprise's safe production and sustainable development

5. Conclusion and Outlook

Under the new circumstances, coal mine safety management faces both challenges and opportunities. By analyzing the current coal mine safety situation and safety management status, this paper proposes innovative safety management strategies based on the application of new technologies, optimization of management systems, improvement of personnel quality, and cultural development. The research shows that coal mine safety management needs to keep pace with the times, fully utilize advanced technologies, improve management systems, enhance personnel quality, and strengthen safety culture development. To ensure the effective implementation of these innovative strategies, coal mining enterprises need to provide safeguards in four areas: organization, systems, technology, and funding. By establishing and improving safety management organizational structures, refining safety management systems, increasing investment in safety technology, and ensuring adequate safety funding, favorable conditions can be created for the implementation of innovative strategies.

In the future, coal mine safety management will continue to develop in the direction of intelligence, refinement, and whole-team involvement. Coal mining enterprises should keep up with the times, continuously innovate safety management concepts and methods, and enhance safety management levels to contribute to the long-term stability of coal mine safety production. At the same time, it is recommended to strengthen industry-academia-research collaboration in the field of coal mine safety to promote the innovation and application of safety technologies; improve the legal and regulatory framework for coal mine safety to strengthen safety supervision; and enhance the development of coal mine safety culture to increase societal attention and support for coal mine safety.

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